(19) JAPANESE PATENT OFFICE

PATENT ABSTRACTS OF JAPAN

(11) Publication number: **11120216 A**

(43) Date of publication of application: **30.04.99**

(51) Int. Cl **G06F 17/50** **G05B 23/02**

(21) Application number: **09280057**

(22) Date of filing: **14.10.97**

(71) Applicant: **OKI ELECTRIC IND CO LTD**

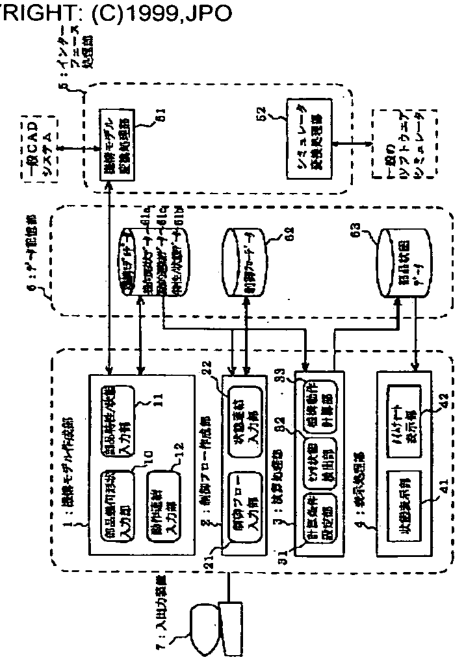
(72) Inventor: **KUNIMINE NAOKI**
FUKAI MASAKATSU
TAKANO YUTAKA
YAMADA ZENSHI
MATSUOKA IWATAROU

(54) **MECHATRONICS EQUIPMENT DESIGN SUPPORTING DEVICE**

(57) Abstract:

PROBLEM TO BE SOLVED: To find out a logic error or simple error on a program in advance without a real machine by providing a mechanism model preparing part for processing the input of mechanism model data, control flow preparing part for processing the input of control flow data, arithmetic processing part for calculating the state change of a component, and display processing part for displaying the state change of the component.

SOLUTION: A mechanism model preparing part 1 processes the input of the mechanism model data containing the geometrical shape data of a mechanical/electric component consisting of a mechanism, characteristic/state data expressing the characteristic and state of the component and the data of dynamic connection relation between the components. A control flow preparing part 2 processes the input of the control flow data (control sequence data) for controlling the operation of the mechanism. An arithmetic processing part 2 calculates the state change (coordinate or state) of the component from the mechanism model data and the control flow data. A display processing part 4 performs processing for displaying the state change of the component on an input/output unit 7 based on the calculated result at the arithmetic processing part 3.



Part translation of Japanese patent application

Publication No: H11-120216-A (Publication date: Apr. 30, 1999)
Application No: H09-280057 (Application date: Oct. 14, 1997)
Applicants: Oki Electric Co., Ltd.
Title: Apparatus for supporting designing work of a computer controlled mechanical device

[0011]

[Embodiments of invention]

Embodiment 1

— Part from this line to the end of paragraph [0013] is not translated. —

[0014] Fig.2 is a flowchart of examination processes in which a computer controlled mechanical device is examined for its correctness using the apparatus of the present invention. In a manner following this examination process flow, operations of a mechanical-structure-model generation unit 1, a controlling-flow generation unit 2, a computing unit 3 and a displaying process unit 4 are explained in the following. A component-geometrical-shape input unit 10 provided in the mechanical-structure-model generation unit 1 has equivalent functions as those of a conventional CAD (computer aided designing) system and is also capable of processing entries of data sets representing geometrically shaped elements such as straight lines, circles and circular arcs and further those called by names such as surface and solid into a set of conventional CAD data acquired and held within the present apparatus via a mechanical-structure-model-transforming processor unit 51 (S1). It is configured further so as to be able to handle a plurality of geometrically shaped elements in form of a group. This means that it is capable of assembling one specific circle and several specific straight lines to form a group and call the group as "gearwheel A". It is further capable of handling a non-materialistic group such as a media guide-way (a pathway banknotes or the like are driven through) as an independent component. The geometrical shape of a component of which the entry has been processed for, is stored in a data storage unit 6 as a geometrical-shape data set 61a.

[0015] A component-feature/status input unit 11 is capable of processing entries of data representing various features and statuses associated with a component or a group comprising a defined set of components (hereafter called "a component group") (S2). The features and statuses imply those of components and component groups and exemplified by 'a component type', 'a type-identify number', 'a signal name' and various other features associated with components and component groups such as a motor, gear or sensor. The various other features may be, if in a case

associated with a motor, the on-or-off status, rotating speed value, rotating direction, lead-time before the rotation reaching the steady state speed and so on. And if in a case associated with a sensor, the features may be a status definition for the sensor to react to or not to, a component group identity number to which the sensor positively reacts to, a delay in time before issuing a reactive signal and so on. Fig.3 shows an example of the input screen employed by the component-feature/status input unit 11 for entering component feature/status data. The feature/status data of which entries have been processed for is stored in the data storage unit 6 as feature/status data sets 61b. A motion-connection input unit 12 processes entries of motional-relation data defining interrelated motions between components of which the entries has been processed for by the component-geometrical-shape input unit 10 and the component-feature/status input unit 11 (S3). It is necessary to have a motional-relation data set to define interrelated motions of a pair comprising a component group, motor A, and another component group, gearwheel B, in which, for instance, the state of the component group, gearwheel B, changes from "standstill" to "rotation" in response to a status change taking place in the component group, motor A, from "standstill" to "rotation". The motion-connection input unit 12 processes a motional-relation data set that is input through an input/output apparatus 7 and stores thus processed data set in the data storage unit 6 as a motional-relation data set 61c.

[0016] A controlling-flow input unit 21 included in a controlling-flow generation unit 2 processes a series of motion-flow data sets as they are input from the input/output apparatus 7 and stores a set of thus obtained data in the data storage unit 6 as a controlling-flow data set 62, in which the motion-flow data sets are concerned with controlling of a mechanical structure (S4). Controlling flows, such as 'a component group, motor B, commences rotation in response to the state of signal A1 issued by another component group, sensor A, changing to "ON" indicating sensor A is in a positive reaction' are described using a control-description-language or flowchart. A status-connection input unit 22 performs a process required to have the controlling-flow input unit 21 and the mechanical-structure-model generation unit 1 exchange their own data in order to avoid both of the units 21, 1 respectively processing entries, in duplication, entry of an input data set of the controlling-flow input unit 21 representing, for instance, 'sensor status is "ON", commence motor A rotation' and entry of the mechanical-structure-model generation unit 1 representing, for instance, 'sensor's ON/OFF status, rotation speed of motor A'. Said exchange of such data is implemented in a manner in which the data storage unit 6 is used as an intermediary between them. In a case in which a mechanical-structure-model has already been generated and statuses of components (such as the sensor's ON/OFF status) are already defined and available, these data sets are used as they are when processing entries of controlling-flow data sets to improve associated processing efficiency. Conversely, in a case in which processing for an entry of a controlling-flow data set is first performed, the statuses defined then for the components are used as they are when generating a

mechanical-structure-model to constitute component status data sets and to improve associated processing efficiency.

[0017] A calculation-condition establishing unit 31 included in the computing unit 3 establishes initial conditions required for commencing calculations. The conditions include values specifying a time interval between calculation runs and initial statuses of respective component groups (S5). On the other hand, a mechanical-movement calculation unit 33 progresses with calculations associated with the respective component statuses in such manners as may be determined by the calculation conditions having been established by the calculation-condition establishing unit 31 (S6). It retrieves, in particular, mechanical-structure-model data sets 61 and the controlling-flow data sets 62 and derives statuses of the components based on contents of these data sets 61 and 62. The results derived in this way are stored in the data storage unit 6 as component-status data sets 63. A sensor-status detecting unit 32 processes data to characterize statuses of components or component groups other that the sensor-status detecting unit 32 itself in a manner correspondent with functions played by sensors disposed throughout a mechanical structure. The sensor-status detecting unit 32, for instance, obtains data sets representing statuses of components from the mechanical-movement calculation unit 33 every after completing its calculation run and processes them to characterize statuses of all the component groups set to be monitored by disposing these sensors. The sensor-status detecting unit 32, when any of the characterized statuses matches with a pre-assigned condition, sends an indication to the mechanical-movement calculation unit 33 to inform of this fact.

[0018] The displaying process unit 4 retrieves component-status data sets 63 output from the computing unit 3 and processes them to display statuses as at every predetermined time (S7). A status display unit 41, for instance, performs processes required for displaying positioning of rotating and/or moving component groups at every hour based on hourly-replenished sets of geometrical-shape data constituting a part of the component-status data sets 63. Said displaying may comprise animated or still pictures. A time-chart displaying unit 42 performs processes required for graphically displaying statuses that change with time. The graphical display, for instance, means a display in which the horizontal axis is set to represent time and the vertical axis is allocated to a signal name selected to display its status for illustrating, in form of a chart, the status such as an ON or OFF state of the selected signal across a timeline. Lastly, the input/output apparatus 7 outputs these results either as screen displays or printed documents (S8).

[0019] Embodiment 2

Fig.4 is a block diagram for illustrating in more detail about the configuration of the mechanical-structure-model generation unit 1 employed in Embodiment 1 and flows of associated data sets. The functions of the component-geometrical-shape input unit 10 and component-feature/status input unit 11 are the same with those assumed in Embodiment 1. The motion-connection input unit 12, here, is composed of a pair of processing units, a connecting-data

input unit 121 and a connecting-data auto-generation unit 122. The connecting-data input unit 121 processes entries of motional-relation data sets concerned with relationships existing between component groups and are input by an operator in an interactive manner. The connecting-data auto-generation unit 122, on the other hand, automatically finds previously stored connecting-data sets and progresses with processes of generating motional-relation data sets. These operations are explained below.

[0020] Fig.5 is a drawing to show an example of input screens associated with the connecting-data input unit 121. The connecting-data input unit 121 reads out component groups defined in mechanical-structure model data sets 61 and displays symbol marks (component symbols), as shown in Fig.5, representing the read out component groups respectively. An operator can draw a motion-connecting line between a pair of symbol marks or between statuses associated with a pair of symbol marks by a mouse operation or the like of an input/output apparatus 7. For entering motional relationships in which a component group, motor A, commences a rotation movement, then another component group, gearwheel B, in response to it, starts to rotate, which further causes yet another component group, gearwheel C, to start to rotate, an operator can draw motion-connecting lines 1a, 1b between component symbols, "motor A" and "gearwheel B", and between component symbols, "gearwheel B" and "gearwheel C". And the operator can complete defining the concerned relationships by further inputting relationships existing between rotation speeds of motor A and gearwheel B and between gearwheel B and gearwheel C, in which the relationships here may be represented, for instance, by a set of ratios among rotation speeds of these components. It is also possible, here, for the operator to enter connection data sets representing structural connections found in structures such as pin-joint or slider-joint structures.

[0021] The connecting-data auto-generation unit 122 automatically finds previously stored connecting-data sets and progresses with processes of generating motional-relation data sets. Provided below is an explanation made, in a manner following the drawing of Fig.6, to the flow of this finding and processing of a connecting-data set that connects rotating motions using a case of connected gearwheels in which all the associated geometrical-shape data sets are those of two-dimensional objects. The connecting-data auto-generation unit 122 retrieves both geometrical-shape data sets 61a and feature/status data sets 61b associated with various components (S11, S12). Then it searches through data sets of component-group names and types for a word, "gearwheel" (S13). And then search through geometrical-shape data sets constituting the thus found component group to find and extract shape elements each representing any circle (S14). And determines whether any pair of the extracted circle elements make a point contact to each other (S15). This determination can be accomplished by a process of finding out circle pairs of which the radii, when added together, equals to the distance between their centers. For each of the point connected circle pairs found out, the connecting-data auto-generation unit 122 generates newly

pieces of data for describing about the "connection" and then drives the rotation speed ratio value from the diameter ratio of the associated circles (S16), and further, it assembles these data pieces and stores in the data storage unit 6 as a motional-relation data set 61c (S17). In the above reviewed manner, motional-relation data sets each for connecting a pair of gearwheels are generated automatically from previously stored connecting-data sets.

[0022] It also generates automatically, in the same manner, connecting-data sets representing connection relationships existing between components with other shapes than circles, a connection relationship between cylindrically shaped components such as rollers and shafts or a connection relationship between a pair of belt and pulley or between a pair of belts. An operator is required to supplement the connecting-data generation by using the connecting-data input unit 121 in cases concerned with connection relationships that cannot be determined only by assessing associated geometrical shapes, of which the examples are those concerned with logical connections such as a relationship existing between a sensor and an actuator. A process of generating a connecting-data set for a logical connection in this way becomes more generally applicable by incorporating a function of describing relationships existing between component statuses in logical formulas or mathematical formulas. The relationship in which the rotation speed of a motor is brought to 2000 rounds per minute when sensors A and B both are aroused and turn to the ON state, for instance, can be described as "sensor A. ON and sensor B. ON = motor. 2000".